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(54) **AUTOMATIC FIELD DEVICE SERVICE ADVISER**

(75) Inventors: **Mark S. Schumacher**, Minneapolis, MN (US); **Evren Eryurek**, Melbourne, FL (US)

(73) Assignee: **Rosemount Inc.**, Eden Prairie, MN (US)

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See application file for complete search history.

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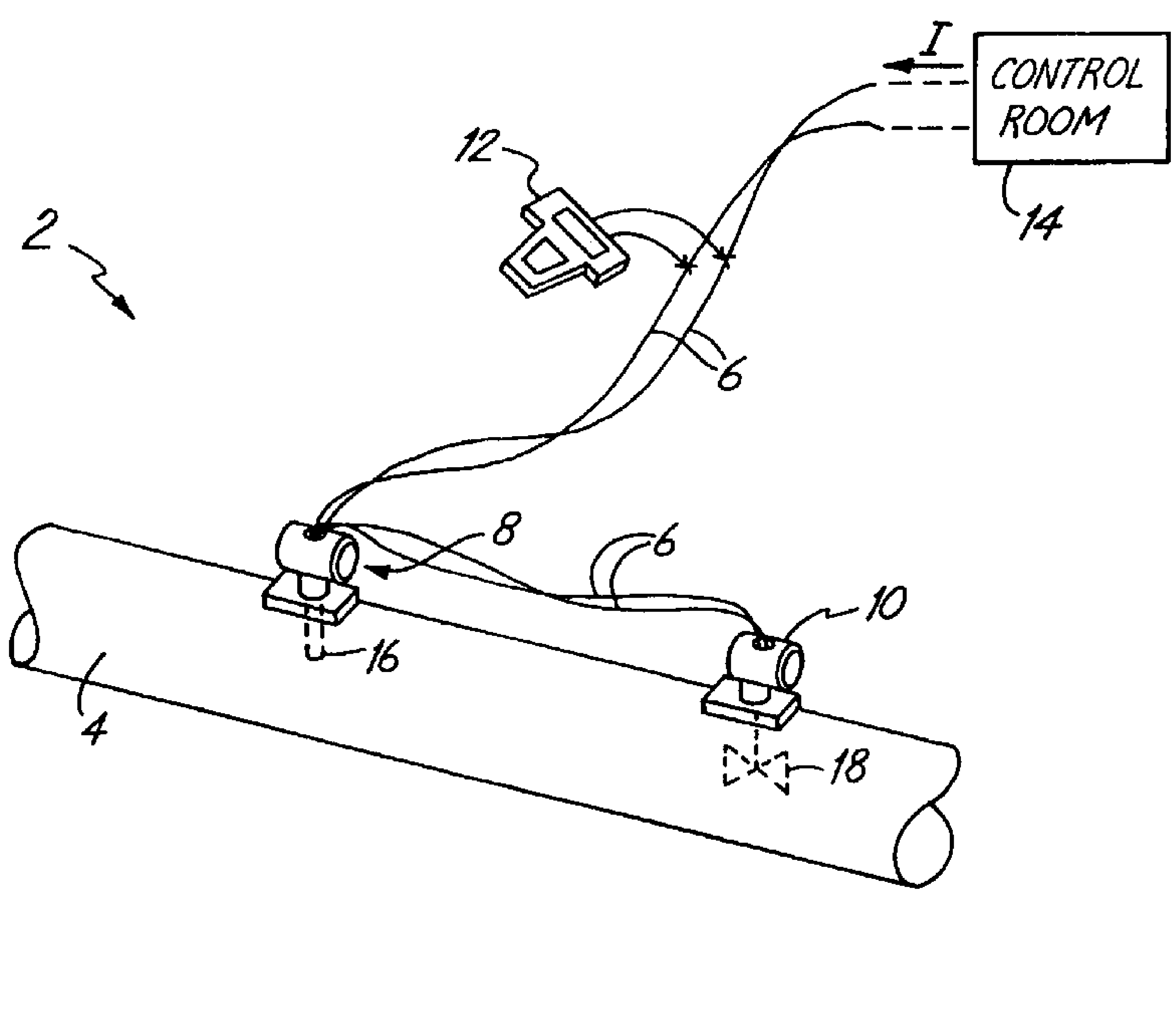
Primary Examiner — Kavita Padmanabhan
Assistant Examiner — Thomas Stevens
(74) *Attorney, Agent, or Firm* — Westman, Champlin & Koehler, P.A.

(57) **ABSTRACT**

A field device resident algorithm receives one or more diagnostic inputs and generates actionable service information. The algorithm(s) can be changed or updated after the manufacture of the field device. The actionable service information can be displayed locally or sent over a process control loop. A prediction engine can be employed to determine a period within which such service should be completed.

25 Claims, 5 Drawing Sheets



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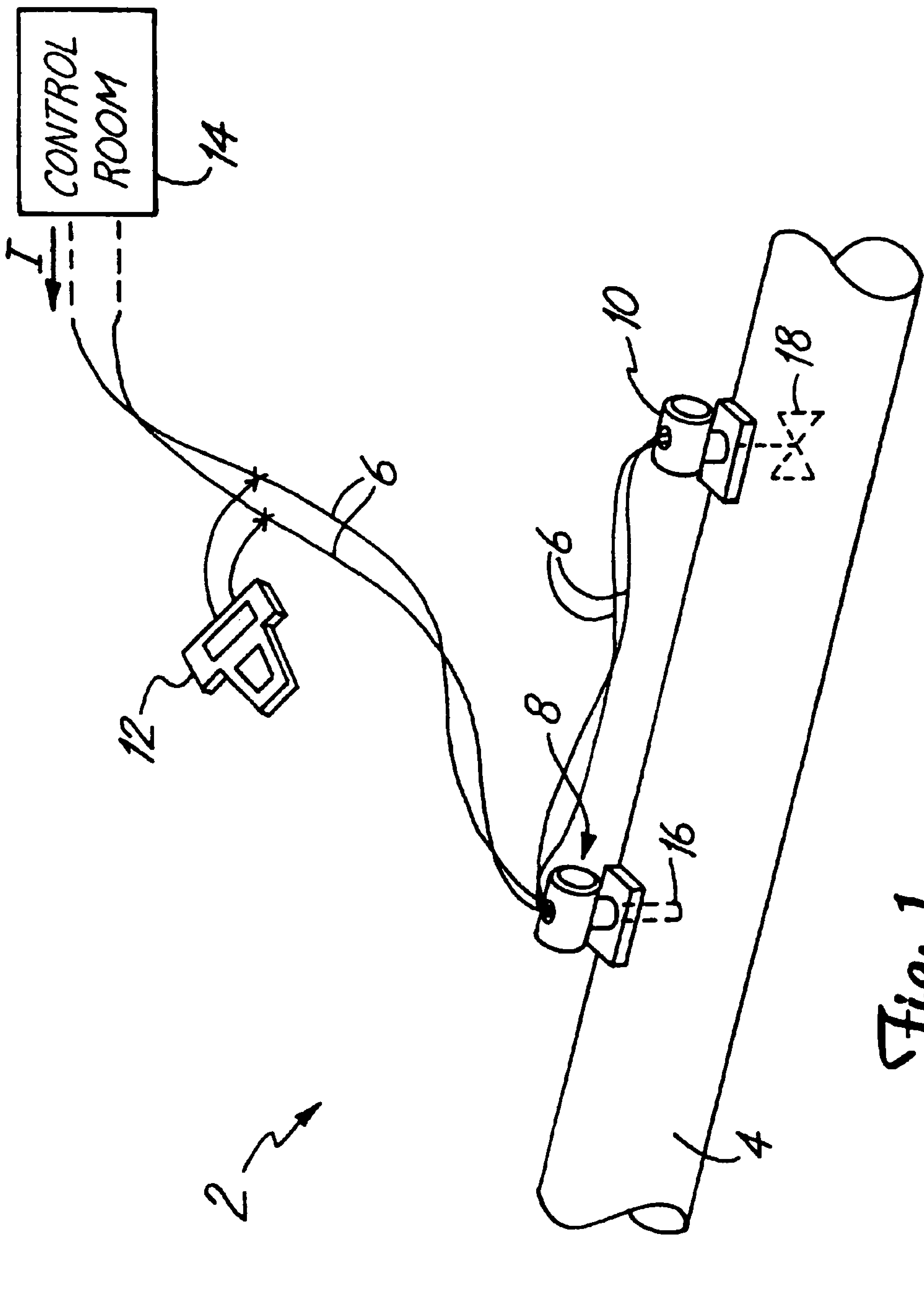

Fig. 1

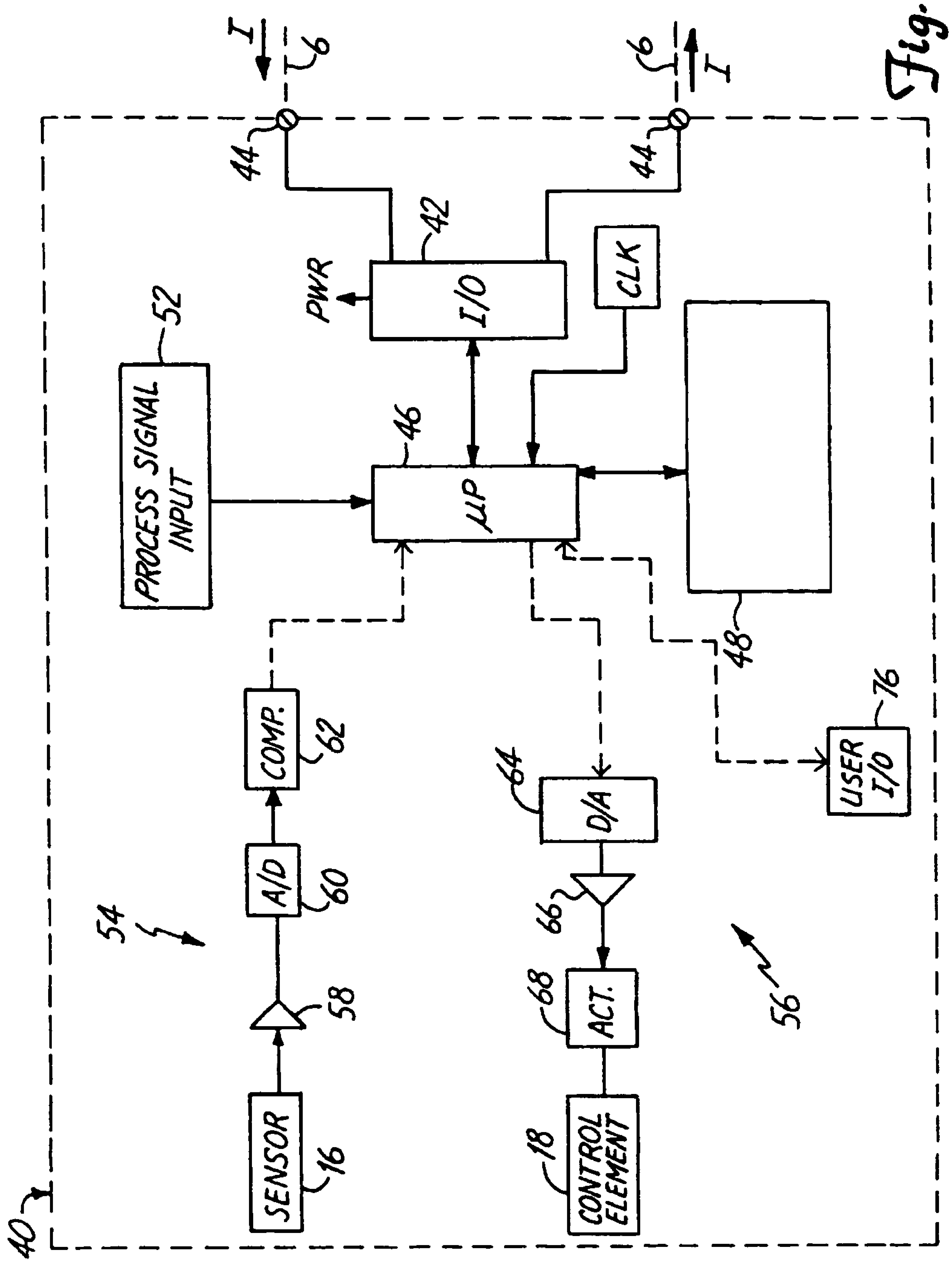
I
6
44
44
6
I
42
PWR
I/O
CLK
52
PROCESS SIGNAL INPUT
46
μP
48
54
COMP.
62
A/D
60
58
SENSOR
16
40
64
D/A
66
68
ACT.
CONTROL ELEMENT
18
56
USER I/O
76

Fig. 2

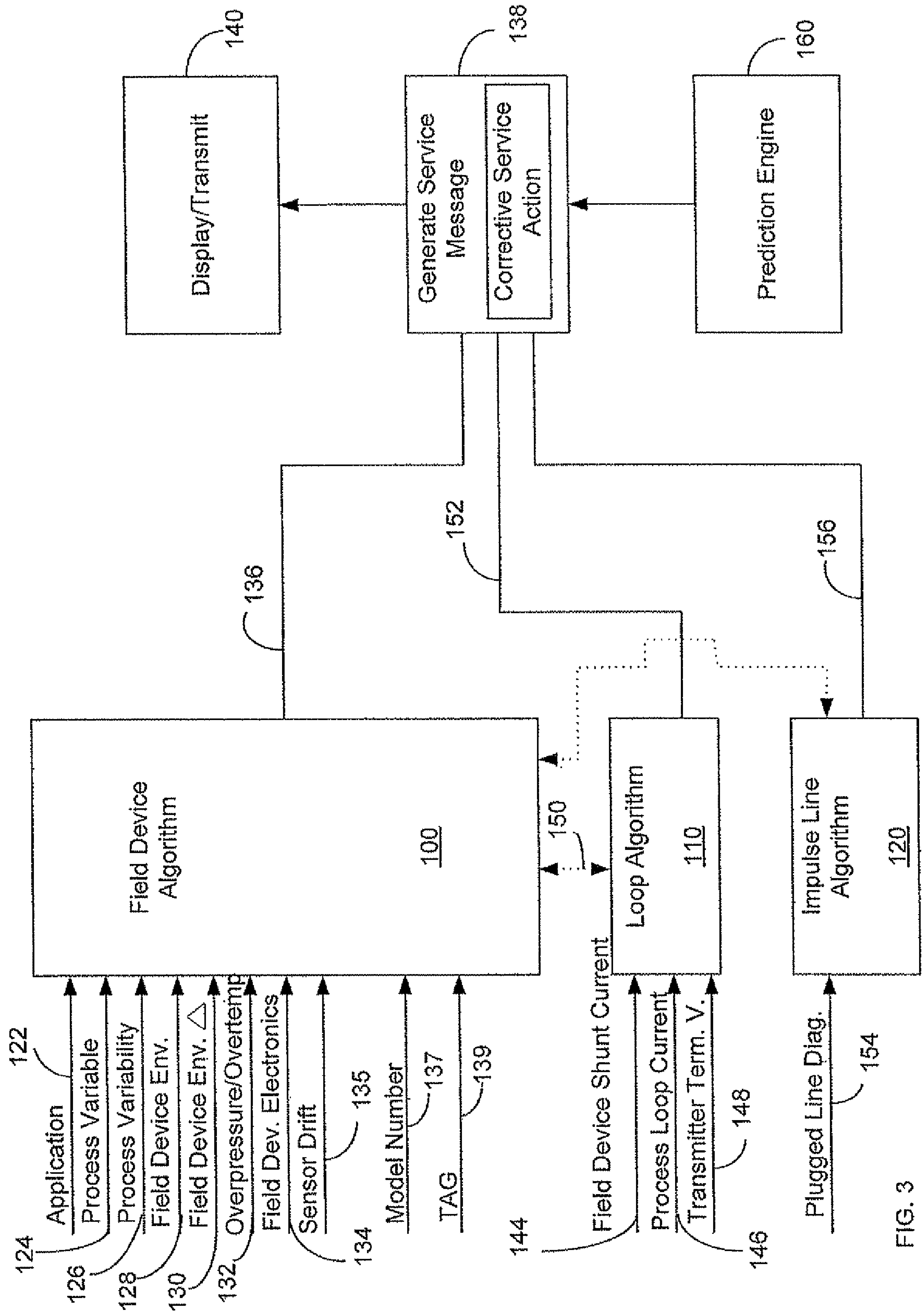
Display/Transmit
140
Generate Service Message
Corrective Service Action
138
Prediction Engine
160
136
152
156
Field Device Algorithm
100
150
Loop Algorithm
110
Impulse Line Algorithm
120
Application
Process Variable
Process Variability
Field Device Env.
Field Device Env. △
Overpressure/Overtemp
Field Dev. Electronics
Sensor Drift
Model Number
TAG
122
124
126
128
130
132
134
135
137
139
Field Device Shunt Current
Process Loop Current
Transmitter Term. V.
144
146
148
Plugged Line Diag.
154

FIG. 3

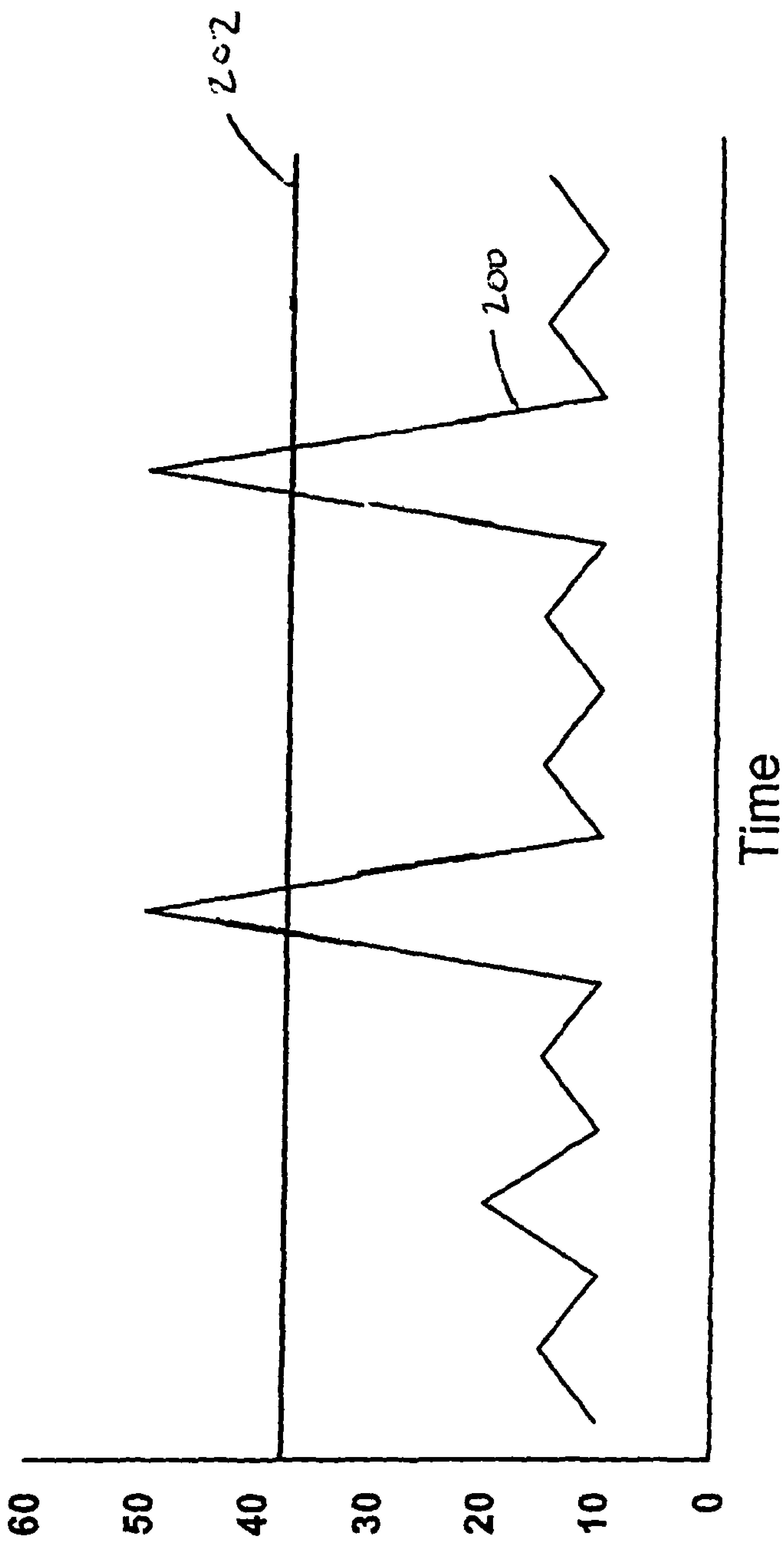

FIG 4

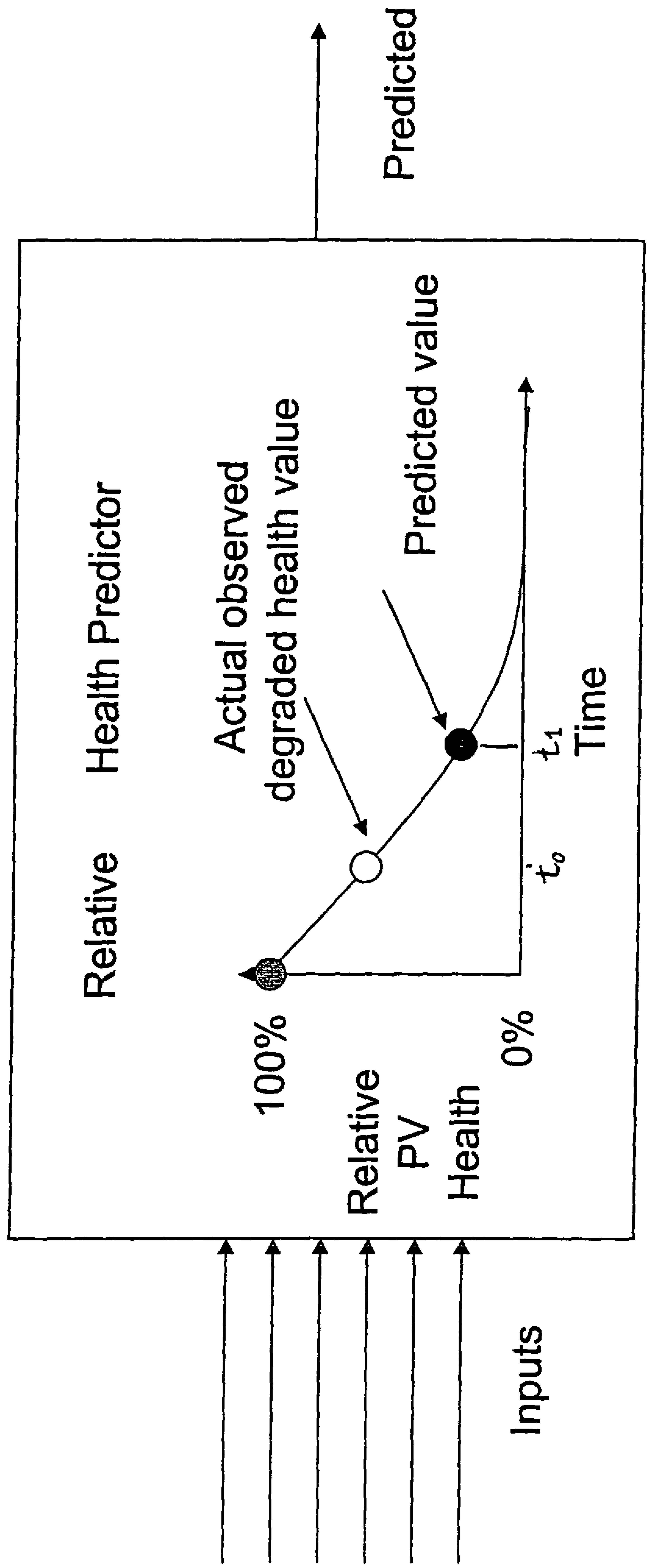
Predicted
Relative
Health Predictor
Actual observed
degraded health value
Predicted value
100%
Relative
PV
Health
0%
t_o
t_1
Time
Inputs

FIG 5

AUTOMATIC FIELD DEVICE SERVICE ADVISER

BACKGROUND OF THE INVENTION

Field devices are used in industries to control or monitor operation of a process such as an oil refinery. A field device, such as a transmitter, is typically part of a process control or monitoring loop and is located in the field to measure and transmit a process variable such as pressure, flow or temperature, for example, to control room equipment. A field device such as a valve controller can also be part of the process control loop and controls position of a valve based upon a control signal received over the process control loop, or generated internally. Other types of controllers control electric motors or solenoids, for example. The control room equipment is also part of the process control loop such that an operator or computer in the control room is capable of monitoring the process based upon process variables received from transmitters in the field and responsively controlling the process by sending control signals to the appropriate control devices. Another field device which may be part of a process control loop is a portable communicator which is capable of monitoring and transmitting process signals on the process control loop. Typically, such devices are used to configure devices which form the process control loop.

With the advent of low-power microprocessors, field devices have undergone significant changes. Years ago, a field device would simply measure a given process variable, such as temperature, and generate an analog indication in the form of a current varying between 4 and 20 (mA) to indicate the measured temperature. Currently, many field devices employ digital communication technology as well as more sophisticated control and communication techniques. Field devices often employ low-power electronics because in many installations they are still required to run on as little as 4 mA. This design requirement prohibits the use of a number of commercially available microprocessor circuits. However, even low-power microprocessors have allowed a vast array of functions for such field devices.

One new function that is enabled by microprocessor-based smart field devices is the generation of diagnostic information. Through adaptations of hardware, software, or both, today's smart field devices are able to assess the condition of process interface elements such as sensors or solenoids, assess their own circuitry, and/or even assess the relative health of the process control loop itself. Rosemount Inc., the Assignee of the present application, has contributed in this area. See, for example, U.S. Pat. Nos. 6,047,220; 5,828,567; 5,665,899; 6,017,143; 6,119,047; 5,956,663; 6,370,448; 6,519,546; 6,594,603; 6,556,145; 6,356,191; 6,601,005; 6,397,114; 6,505,517; 6,701,274; 6,754,601; 6,434,504; 6,472,710; 6,654,697; 6,539,267; 6,611,775; 6,615,149; 6,532,292; and 6,907,383.

The result of these significant developments in the area of diagnostics for microprocessor-based smart field devices is that a wealth of information is now available relative to numerous aspects of field devices in various process installations. However, considering that a given process installation may include tens, or even hundreds of such microprocessor-based field devices, an operator or technician could easily become overwhelmed by the sheer amount of diagnostic data provided during operation.

A method of processing diagnostic data in order to better utilize the finite maintenance resources of a process installation would increase the degree to which process installations could utilize the wealth of diagnostic information available today.

SUMMARY

A field device resident algorithm receives one or more diagnostic inputs and generates actionable service information. The algorithm(s) can be changed or updated after the manufacture of the field device. The actionable service information can be displayed locally or sent over a process control loop. A prediction engine can be employed to determine a period within which such service should be completed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified diagram showing a process control loop including a transmitter, controller, hand-held communicator and control room.

FIG. **2** is a block diagram of a field device with which embodiments of the present invention can be practiced.

FIG. **3** is a block diagram illustrating a number of algorithmic blocks in accordance with embodiments of the present invention.

FIG. **4** is a chart illustrating variation in a health indication over time, in accordance with an embodiment of the present invention.

FIG. **5** is an illustrative chart showing how a health indication can be predicted along a degradation curve.

DETAILED DESCRIPTION

Process variables are typically the primary variables which are being controlled or monitored in a process. As used herein, process variable means any variable which describes the condition of the process such as, for example, pressure, flow, temperature, product level, pH, turbidity, vibration, position, motor current or any other characteristic of the process. A diagnostic signal, as used herein, includes information related to operation of devices and elements in the process control loop or even the process itself. For example, diagnostic signals can include valve stem position, applied torque or force, actuator pressure, pressure of a pressurized gas used to actuate a valve, electrical voltage, current, power, resistance, capacitance, inductance, device temperature, stiction, friction, full on and off positions, travel, frequency, amplitude, spectrum and spectral components, stiffness, electric or magnetic field strength, duration, intensity, motion, electric motor back emf, motor current, loop related parameters (such as control loop resistance, voltage, or current), or any other parameter which may be detected or measured in the system.

FIG. **1** is a diagram showing an example of a process control system **2** which includes process piping **4** which carries a process fluid and two wire process control loop **6** carrying loop current I. A transmitter **8**, controller **10**, which couples to a final control element in the loop such as an actuator, valve, a pump, motor or solenoid, communicator **12**, and control room **14** are all part of process control loop **6**. It is understood that loop **6** is shown in one configuration and any appropriate process control loop may be used such as a 4-20 mA loop, **2**, **3** or **4** wire loop, multi-drop loop and a loop operating in accordance with the HART®, Fieldbus or other digital or analog communication protocol. Alternatively, the process control loop may employ various wireless communication techniques. In operation, transmitter **8** senses a process variable such as flow using sensor **16** and transmits the sensed process variable over loop **6**. The process variable may be received by controller/valve actuator **10**, communicator **12** and/or control room equipment **14**. Controller **10** is shown coupled to valve **18** and is capable of controlling the process by adjusting valve **18** thereby changing the flow in pipe **4**. Controller **10** receives a control input over loop **6** from, for example, control room **14**, transmitter **8** or communicator **12** and responsively adjusts valve **18**. In another embodiment, controller **10** internally generates the control signal based upon process signals received over loop **6**. Communicator **12** may be the portable communicator shown in FIG. **1** or may be a permanently mounted process unit which monitors the process and performs computations. Field devices include, for example, transmitter **8** (such as a 3051S transmitter available from Rosemount Inc.), controller **10**, communicator **12** and control room **14** shown in FIG. **1**. Any of field devices **8**, **10**, **12** or **14** shown in FIG. **1** may include enhanced diagnostic signal processing in accordance with embodiments of the present invention.

FIG. **2** is a block diagram of one example of a field device **40** forming part of loop **6**. Device **40** is shown generically and may comprise any field device such as transmitter **8**, controller **10**, or communicator **12**. Control room equipment **14** may comprise, for example, a DCS system implemented with a PLC and controller **10** may also comprise a "smart" motor and pump. Field device **40** includes I/O circuitry **42** coupled to loop **6** at terminals **44**. I/O circuitry has preselected input and output impedance known in the art to facilitate appropriate communication from and to device **40**. Device **40** includes microprocessor **46**, coupled to I/O circuitry **42**, memory **48** coupled to microprocessor **46** and clock **50** coupled to microprocessor **46**. Microprocessor **46** receives a process signal input **52**. Block input is intended to signify input of any process signal such as a process variable, or a control signal and may be received from loop **6** using I/O circuitry **42** or may be generated internally within field device **40**. Field device **40** is shown with a sensor input channel **54** and a control channel **56**. Typically, a transmitter such as transmitter **8** will exclusively include sensor input channel **54** while a controller such as controller **10** will exclusively include a control channel **56**. Other devices on loop **6** such as communicator **12** and control room equipment **14** may not include channels **54** and **56**. It is understood that field device **40** may contain a plurality of channels to monitor a plurality of process variables and/or control a plurality of control elements as appropriate.

Sensor input **54** includes sensor **16**, sensing a process variable and providing a sensor output to amplifier **58** which has an output which is digitized by analog to digital converter **60**. Input **54** is typically used in transmitters such as transmitter **8**. Compensation circuitry **62** compensates the digitized signal and provides a digitized process variable signal to microprocessor **46**. In one embodiment, input **54** comprises a diagnostic channel which receives a diagnostic signal.

When field device **40** operates as a controller such as controller **8**, device **40** includes control channel **56** having control element **18** such as a valve, for example. Control element **18** is coupled to microprocessor **46** through digital to analog converter **64**, amplifier **66** and actuator **68**. Digital to analog converter **64** digitizes a command output from microprocessor **46** which is amplified by amplifier **66**. Actuator **68** controls the control element **18** based upon the output from amplifier **66**. In one embodiment, actuator **68** is coupled directly to loop **6** and controls a source of pressurized gas (not shown) to position control element **18** in response to the current I flowing through loop **6**. In one embodiment, controller **10** includes control channel **56** to control a control element and also includes sensor input channel **54** which provides a diagnostic signal such as valve stem position, force, torque, actuator pressure, pressure of a source of pressurized air, etc.

In one embodiment, I/O circuitry **42** provides a power output used to completely power other circuitry in process device **40** using power received from loop **6**. Typically, field devices such as transmitter **8**, or controller **10** are powered off the loop **6** while communicator **12** or control room **14** has a separate power source. As described above, process signal input **52** provides a process signal to microprocessor **46**. The process signal may be a process variable from sensor **16**, the control output provided to control element **18**, a diagnostic signal sensed by sensor **16**, or a control signal, process variable or diagnostic signal received over loop **6**, or a process signal received or generated by some other means such as another I/O channel.

A user I/O circuit **76** is also connected to microprocessor **46** and provides communication between device **40** and a user. Typically, user I/O circuit **76** includes a display and audio for output and a keypad for input. Typically, communicator **12** and control room **14** includes I/O circuit **76** which allows a user to monitor and input process signals such as process variables, control signals (setpoints, calibration values, alarms, alarm conditions, etc.) along with rules, sensitivity parameters and trained values. A user may also use circuit **76** in communicator **12** or control room **14** to send and receive such process signals to transmitter **8** and controller **10** over loop **6**. Further, such circuitry could be directly implemented in transmitter **8**, controller **10** or any other process device **40**.

Microprocessor **46** acts in accordance with instructions stored in memory **48**. Various instructions stored within memory **48** allow microprocessor **46** to execute one or more algorithms within the field device in accordance with embodiments of the present invention. In general, the algorithms allow the field device to obtain one or more diagnostic inputs and generate a service-related recommendation output. Diagnostic information useful as input to the algorithm(s) can include any diagnostic information that has been currently developed, or will be developed. In contrast to types of diagnostic output that have been provided in the past, the field device service advisor recommends a particular service to be performed relative to the field device, components connected to the field device, to other field devices, or to the process control loop itself.

As can be imagined, if the tens or hundreds of field devices in a given process installation were providing various types of diagnostic information over process control loops, it could inundate an operator with such a vast amount of information that he or she may not be able to adequately determine what type or quantity of corrective action should be instituted with respect to a give piece or pattern of diagnostic information. Moreover, the sheer volume of diagnostic information itself could consume valuable communication bandwidth on the process control loop thereby reducing, or degrading the ability for process variable information to be communicated timely and effectively. Embodiments of the present invention preferably include a field device-resident algorithm that is able to take one or more inputs, including diagnostic inputs, and provide a service action recommendation. In this way, the field devices themselves can make a number of decisions about what types, quantity and timing of corrective service actions should be taken. Then, this singular message can be displayed by the field device, or communicated to a control room.

FIG. **3** is a diagrammatic view of various service adviser algorithms in accordance with embodiments of the present invention. Preferably, each of algorithms **100**, **110** and **120** are used by microprocessor **46** executing suitable instructions stored within memory **48**. While algorithms **100**, **110** and **120** are illustrated and described separately, such illustration is for clarity, and, in fact, all or any algorithms could be combined, as appropriate.

Field device algorithm **100** takes any suitable inputs related to the field device itself. Examples of suitable inputs include, but are not limited to, application input **122** (such as flow, level or pressure); process variable input **124**; process variability input **126**; field device environmental input **128**; field device environmental change input **130**; overpressure/overtemp input **132**; field device electronics input **134**; sensor drift **135**; field device model number input **137** and field device tag input **139**.

An example of process variable input **124** generally includes the value, either currently or historically, or both of the process variable of the field device. For example, if the field device is a pressure transmitter, then process variable **124** could be the actual process pressure value, history of values or any combination thereof.

Process variability input **126** is generally an indication of the variability of the process variable over a specified period. For example, process variability input may be a standard deviation calculation on an historical range of process variable values, or simply the difference between a local minima and local maxima of the process variable observed within a specified period of time.

Field device environmental input **128** includes any suitable parameter that may bear upon the operation of the field device itself. Examples of such parameters include the temperature of the field device itself, as measured by an internal temperature sensor, the relative humidity proximate the exterior of the field device, radio frequency interference that may be measured or detected by the field device, or any other external influences to the field device that can be measured, and that can bear upon the field device operation.

Input **130** is preferably based upon a mathematical operation on a history of values provided by input **128**. For example, if input **128** includes a measurement of the temperature of the field device itself, input **130** can simply be an indication of whether the temperature of the field device is changed by a specific amount within a specific time.

Input **132** is preferably a measure of whether a field device is exposed to any relative extremes of the process variable. For example, if the field device is a pressure transmitter, input **132** is an indication of whether the pressure transmitter was subjected to an overpressure event, and if so, the duration and number of such overpressure events.

Input **134** can be generated by diagnostics run on or by the field device electronics itself. While not specifically illustrated, field device algorithm **100** can include other suitable diagnostic inputs relative to the field device. Moreover, as the state of field device diagnostics advances, it is contemplated that other types of field device diagnostic information could be provided to algorithm **100**.

An example of sensor drift **135** includes an indication that the sensor, when subjected to a known characteristic, such as temperature for a temperature sensor, exhibits a reading that has changed over time. Sensor drift can occur as a sensor begins to wear, and some level of drift may be acceptable, while still indicating that service should be performed.

An example of field device model number input **137** includes data that is provided to algorithm **100** relative to the model number of the field device itself. Many field device manufacturers provide model numbers that may be parsed, at least to some degree, to provide a description of the field device. For example, a particular model code may describe the material of construction of the field device, the range of the field device, as well as any performance enhancements present in the field device. Thus, algorithm **100** may take such information into account during processing and modify the service message accordingly.

An example of field device tag input **139** is any data provided to algorithm **100** by a user, either locally or through remote means, that is an indication of a type of service performed by the field device. For example, pressure and differential pressure transmitters measure pressure, flow or level. The tagging convention may call for pressure applications to be tagged "PT", for example PT-**101**. Flow application may be tagged "FT" and level applications tagged "LT."

Field device algorithm **100** generally takes one or more of inputs **122**, **124**, **126**, **128**, **130**, **132**, **134**, **135**, **137** and **139**, and processes such inputs to generate actionable information regarding service on line **136**. The specifics of algorithm **100** can be developed via empirical means through controlled testing, and/or can include specific rules relative to conditions of one or more inputs that generate actionable information regarding service. For example, testing may show that a combination of high process variability **126** and high sensor temperature requires service in the form of "inline zero of the field device every X hours." This actionable service information can then be reported along line **136** to block **138** which may simply display or transmit the service information at block **140**.

Loop algorithm **110** takes as inputs field device shunt current diagnostic **144**; process loop current diagnostic input **146**; field device terminal voltage **148**; and potentially any output provided by field device algorithm **100**, as illustrated in phantom at line **150**.

An example of field device shunt current diagnostics **144** includes a measurement of the current consumed by field device **144** in its normal operations.

An example of process loop current diagnostics input **146** includes measurement of current able to be provided over the process communication loop to which the field device is connected.

An example of field device terminal voltage diagnostic input **148** includes measurement of the voltage across the field device terminals where the field device couples to the process communication loop.

As illustrated by the bi-directional arrows on phantom line **150**, loop algorithm **110** may provide an output that is input to field device algorithm **100**. Loop algorithm **110** takes one or more inputs **144**, **146**, **148** and **150**, and generates actionable information regarding service of the loop along line **152**.

Impulse line algorithm **120** generally receives plugged line diagnostic **154** but may receive any other information that may reasonably indicate a plugged impulse line condition. Impulse lines are conduits that convey pressure from an isolator diaphragm to a pressure sensor module. If such lines become plugged, or otherwise damaged, their ability to convey pressure from the isolation diaphragm to the sensor module may also become diminished. The ability to detect this condition is important. As illustrated in FIG. **3**, impulse line algorithm line **120** may take an input from, or provide an output to, any of field device algorithm **100** and loop algorithm **110**. Impulse line algorithm **120** provides actionable information regarding service of the impulse lines along line **156**.

Examples of actionable service information provided by algorithms **100**, **110** or **120** include: in-line zero field devices; blow down impulse lines; shop calibrate; check wiring/power supply; clear impulse lines; shop/factory calibrate; check capillary system; or any other suitable user-defined action that may be provided by the algorithms.

In accordance with an embodiment of the present invention, the algorithms themselves can be modified or updated as appropriate. Accordingly, as new relationships between field device diagnostic information and actionable service recommendations are correlated, such new correlations between the inputs and the actionable service outputs can be updated to the field devices. These updates can take numerous forms. The local ROM of the field device may be exchanged; updated file information may be transmitted to the field device over the process control loop; or a secondary communication interface, such as a wireless communication link with a field maintenance device.

Each of lines **136**, **152** and **156** provides service information to module **138**. Module **138** may combine the information into a signal message, and/or may engage predication engine **160** to determine when such actionable service information should be effected. For example, if field device algorithm **100** provides an indication that a particular field device service action is required, prediction engine **160** may be consulted to provide a time period within which such action should be effected.

Additionally, or in the alternative, module **138** may combine, or otherwise process, the information output over one or more of lines **136**, **152** and **156** to generate an overall "health" indication or metric. This overall health indication can be displayed locally at the device, communicated over the process control loop, and/or used in conjunction with prediction engine **160** to calculate a point in the future when the health indication will reach a threshold beyond which corrective action is necessary.

Prediction engine **160** can include or utilize any known algorithmic and/or mathematical techniques to predict, based on historical data, programmatic data, empirical data, or any combination thereof, when a particular service action should be required. Examples of known techniques which can be employed in or by prediction engine **160** include the use of polynomial curve fits, neural networks, threshold circuitry, and/or fuzzy logic. Further detail regarding these techniques may be found in U.S. Pat. No. 6,701,274.

The polynomial curve fit technique employs empirical models or polynomial curve fitting in microprocessor **46**. A polynomial-like equation which has a combination of any suitable input signals as the variable terms in the polynomial, together with constants stored in memory **48** can be used for computing a future time period within which a particular service action should be effected. If field device memory **48** is limited, the constants and/or equation may be sent over process communication loop **6**.

Neural networks provide another useful technique for prediction engine **160**. In particular, the neural network can be implemented with a multi-layer neural network. Although a number of training algorithms can be used to develop a neural network model for different goals, one embodiment includes using the known back propagation network (BPN) to develop neural network modules which will capture the non-linear relationship among a set of inputs and outputs. The number of inputs to the neural network may differ depending on the complexity of the system, and any one or combination of multiple inputs can be used.

Threshold circuitry can also be used to provide important functions for prediction engine **160**. In particular, microprocessor **46** may consult with, or include such threshold circuitry. Rules resident within, or executed by microprocessor **46** may be implemented in either digital or analog circuitry. For example, the following is a sample if-then rule for spikes in pressure sensor output from a pressure sensor: if the number of spikes detected since commissioning multiplied by a value in memory **48** is greater than an upper threshold, then indicate that the pressure sensor must be replaced within X days. This is merely one illustrative example of threshold circuitry being used in conjunction with if-then rules to facilitate prediction engine **160**.

Fuzzy logic is yet another technique that can be employed for prediction engine **160**. In particular, using fuzzy logic, input data can be processed as a function of a membership function which is selected based upon a value of the input data. Such fuzzy logic techniques are well suited for inputs which fall in a non-linear or non-binary fashion.

Using prediction engine **160**, the field device can generate actionable service information augmented with an interval within which the service action should be completed. Specifically, service notifications, such as blow down impulse line can be augmented to, "blow down impulse line within X hours." These services notifications generally take the form of take "X" action within "Y" time. The time attribute can recite a specific incremental time in the future, such as "within six hours" can recite an interval such as "daily" or can recite a specific time in the future. It is also preferred that each field device be shipped with default settings in memory **48** such that the service adviser algorithm will generate an initial startup recommendation action such as "factory calibrate unit in 60 months."

As the field device gains successful runtime, it is also contemplated that the prediction algorithm can be automatically modified such that the successful runtime is taken into account. Thus, a given field device that notes a diagnostic input that has a recommended service action may not recommend the service action as urgently if the field device has run successfully for ten years, in comparison to field device that is just starting its field operation.

FIG. **4** is a chart illustrating variation in a health indication over time, in accordance with an embodiment of the present invention. Health indication **200** is compared with index **202** to determine whether the overall health necessitates corrective action. Index **202** can be established in any suitable manner, but is preferably established using High Accelerated Life Testing (HALT) with an index related thereto stored in each field device. As illustrated in FIG. **4**, the health indication experiences two excursions beyond index **202**. Such excursions may be caused by any of a variety of variables, or combinations thereof. Each field device preferably includes rules that cause the field device to report degradation if any such excursions are experienced, or the field device may report degradation after a set number or duration of excursions have occurred.

FIG. **5** is an illustrative chart showing how health indication **200** can be predicted along a degradation curve. Thus, an actual health indication observed at time to can be used to calculate that the health indication will reach a certain level at time t_1. Thus, the actionable service information can include a time in the future when one or more actions should be performed. By calculating the degradation slope, even a first order mathematical model can be used to predict when the health indication will reach a certain threshold. Prediction engine **160** can use any suitable technique, or combination of techniques listed above, implemented in software, hardware, or any combination thereof.

Embodiments of the present invention generally provide a number of advantages in the field of diagnostics for smart microprocessor-based field devices. Embodiments generally provide a user with actionable information regarding service versus ambiguous raw alarm data. Further, users are provided with predictive information so that action may be taken before the process variable information is too bad to use for control. Further still, the various algorithms can be developed and refined empirically via a control test program. Further still, the algorithm is preferably resident in field device memory which reduces host dependency. Finally, the recommended maintenance action can be reported in any suitable manner, including via enhanced Electronic Device Description Language (EDDL) technology.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

What is claimed is:

1. A field device comprising a process variable transmitter, comprising:

a process variable sensor configured to sense a process variable of an industrial process;

a microprocessor;

a memory operably coupled to the microprocessor;

a plurality of diagnostic inputs operably coupled to the microprocessor;

wherein the microprocessor implements field device resident algorithms based upon instructions stored in the memory including:

a plurality of diagnostic algorithms based upon the plurality of diagnostic inputs, wherein the plurality of diagnostic algorithms provide a service information output indicative of actionable service information comprising a corrective service action which should be performed based upon the plurality of diagnostic inputs;

a prediction engine implemented by a prediction algorithm configured to determine a service interval within which the corrective service action should be performed, the service interval based upon a health indication degradation curve used to predict when a health indication will reach a threshold level and wherein the prediction algorithm is modified based upon successful runtime of the process variable transmitter;

a service message module configured to generate a service message based upon the service interval and the corrective service action; and

I/O circuitry configured to transmit information related to the sensed process variable and further configured to transmit the service message including the corrective service action and an augmented service interval to another location.

2. The field device of claim **1**, including a local display coupled to the microprocessor which displays the service message including the corrective service action and wherein the corrective service action is related to at least one of the field device itself, a component coupled to the field device, a second field device, and a process control loop.

3. The field device of claim **1**, wherein the at least one of the diagnostic inputs includes a field device diagnostic input.

4. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes application information.

5. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes a process variable.

6. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes process variability.

7. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes a characteristic of an environment of the field device.

8. The field device of claim **1**, wherein the at least one of the diagnostic inputs also includes relative changes in an environment of the field device.

9. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes an indication of exposure of the field device to extremes in process variables.

10. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes a diagnostic of electronics of the field device.

11. The field device of claim **2**, wherein the at least one of the diagnostic inputs includes sensor drift.

12. The field device of claim **1**, wherein the at least one of the diagnostic inputs includes a loop diagnostic input.

13. The field device of claim **12**, wherein the at least one of the diagnostic inputs includes field device shunt current.

14. The field device of claim **12**, wherein the at least one of the diagnostic inputs includes process loop current.

15. The field device of claim **12**, wherein the at least one of the diagnostic inputs includes field device terminal voltage.

16. The field device of claim **1**, wherein the at least one of the service-related recommendation output is transmitted over a process control loop.

17. The field device of claim **16**, wherein the at least one service-related recommendation output is transmitted using enhanced Electronic Device Description Language technology.

18. The field device of claim **1**, wherein one of the plurality of diagnostic algorithms comprises a field device diagnostic algorithm.

19. The field device of claim **1**, wherein one of the plurality of diagnostic algorithms comprises a loop diagnostic algorithm.

20. The field device of claim **1**, wherein one of the plurality of diagnostic algorithms comprises an impulse line diagnostic algorithm.

21. The field device of claim **1**, wherein the prediction algorithm is implemented using a polynomial curve fit.

22. The field device of claim **1**, wherein the prediction algorithm is implemented using a neural network.

23. The field device of claim **1**, wherein the prediction algorithm is implemented using rules.

24. The field device of claim **1**, wherein the prediction algorithm is implemented using fuzzy logic.

25. The field device of claim **1**, wherein the health indication degradation curve is implemented using a mathematical model.

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